Electronics Testing and Production DB

A. Ciocio, K. Einsweiler, and J. Richardson, LBNL

Define basic collection of tests and results:

- Basic items at this level are individual FE, MCC, and opto-electronics die.
- Assembly information links tested die together into a module (different part of database).

The corresponding test records would then be created:

- Same basic testing protocols would be used at various stages of module assembly, so many versions of basic data structures would be associated with a module, and would document its behavior throughout the assembly process.
- Major goals are failure tracking and analysis to optimize production, as well as detailed record of performance of all detector elements.

Basic Testing Points in Module Assembly

First test of components, then assemblies:

- Wafer probing of FE, MCC, and opto-electronics

- Once flip-chipped modules return from bump-bonding/flip-chipping, they would be tested again.

- Flex would be tested after component mounting and prior to attachment to bare module.

- Complete module characterization performed, including temperature cycling and burn-in followed by thorough measurements.

- Modules would be tested again after assembly on local supports (staves and sectors).

- Modules would be tested again after assembly into complete units (disks and barrel layers), and would continue to be periodically tested during remainder of assembly and commissioning.

- No proposal yet made for how optolinks will be tested and burned in.

- One issue is what kind of periodic irradiation testing is required? Periodically dice single chips from both sensor and electronics wafers, irradiate and characterize ? Periodically build modest number of single-chip assemblies and test ?

- Another issue is transition to ATLAS operating mode (periodic calibrations).

Major test point is once module is fully assembled:

- First step would be temperature cycling tests. Test cycle would be done using a PLL-like system. This should involve placing the module in a vacuum chuck and Nitrogen box, which would be temperature cycled in an environmental chamber. Perhaps one would do an initial test at the minimum allowed operating temperature (-20 C ?), followed by a series of temperature cycles up and back down, with further testing, to check for poor connections or mechanical problems.

- This would be followed by a burn-in sequence, in which perhaps 16 modules would be processed in parallel (module production rate per site at least 2 modules per day, burn-in of perhaps 10 days). The modules could be operated by a PLL-like system with an input/output multiplexer so that all would receive XCK, L1, etc., but one would periodically cycle through all of them running standard module tests.

- It is not clear whether this burn-in test should involve elevated stress levels (e.g., higher T) in order to provoke failures of weak modules, or whether this would simply harm otherwise good modules. Whatever temperature cycling is involved must be included in the initial mechanical analysis to be sure it does no mechanical damage.

- These steps would be followed by detailed characterization.

Tests to be done after single module burn-in could include:

- Standard wafer-probe tests (supply currents versus voltage, register tests, digital inject pattern tests, analog threshold scans), and possibly some tests of operating margins (operation versus frequency and versus supply voltage).

- Additional charge calibration as done now for H8 (cross-correlates internal charge injection with narrow X-ray source like Cd109).

- Additional timing scans to check timing uniformity on module and timewalk performance. Possibly use laser scan to provide absolute external time check, in which case there should be at least several windows in the Flex for laser access.

- Issue: Flex obscures easy access to sensor surface, making laser and low-E X-ray source scans rather painful. X-ray source like Cd109 very effective for checking module (self-trigger rate of 50KHz achieved allowing rapid test). Higher energy X-ray (Am241) has much lower counting rate. Switching to β source (Sr or Ru) requires collimation and trigger for high-quality test, which is slow.

Following these tests, modules would be placed on local mechanical structures (sectors and staves):

- Would again perform basic module characterizations, this time with cooling. Presumably would check thermal performance with IR imaging system. This could probably still be performed with PLL-like system, one module at a time.

- As local mechanical structures get assembled into global structure, and real cable harnessing is connected, would continue to perform frequent basic checks. However, as the number of modules continues to increase, will need to progress to real ROD-based readout system with real optical readout.

Commissioning period will produce large amounts of data

- Expect again that many of the tests will be similar, and will allow first real assessment of electronics stability in system environment.

Periodic calibrations will also be required during operation to track basic performance:

- Threshold and noise scans and timewalk scans, with possible optimization of chip operating points as sensors and electronics get radiation damaged.

- Delay scans to ensure optimal timing of L1 trigger and XCK for each module.

- TOT charge calibrations, particularly as sensors start to produce leakage current and shaping properties change.

<u>FE Electronics Production DB strategy</u>

Want to record all basic tests for a given item:

- Allows tracking of yield at each step and analysis of possible failures that develop during production and testing. For example, for die, want to be able to track die locations, probing conditions, and wafer/lot information for future failure analysis.

- For module assembly, would also want to track lot information for all components (passive components like capacitors, Flexes, adhesives, etc.) as well as all processing issues (temperature cycling for adhesives, particular tooling and handling steps taken, etc.) as this may be very relevant for yield optimization and failure analysis.

- Develop consistent picture of module performance under a wide variety of conditions, and optimize production efficiency.

Beginning work of creating list of tests and data produced:

- Present FE wafer probing done using PixelDAQ program.

- This produces massive amounts of raw data, and careful thought is required as to how best to digest and record summaries of this data.

- We still plan to use data produced by PixelDAQ for FE-B wafer probing to prototype DB test records and remote data entry issues, but other electronics issues have had higher priority recently...